Electronics developments in Orsay, France

Albrecht Karle

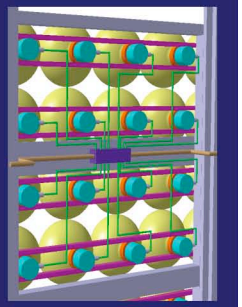
Summary from a visit in Orsay,

Thanks to

Jean-Eric Campagne, Joël Pouthas and the Orsay team.

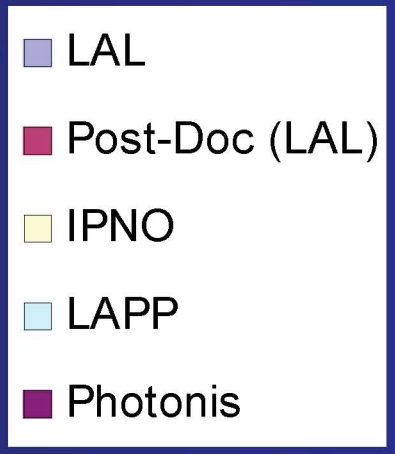
The following slides are (mostly) taken from presentations by the Orsay team during the visit in January.

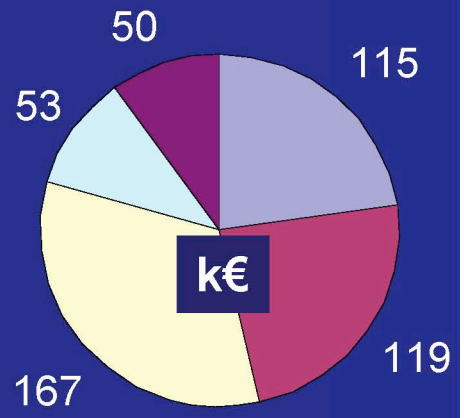
PMm^2 ANR (2007-2009)



- LAL: front end electronics + water tight box
- IPNO: photodetector tests + mechanics + integrated electronic board
- LAPP: Data network (electronics + cables + protocol but not DAQ)
- Photonis: PMTs provider

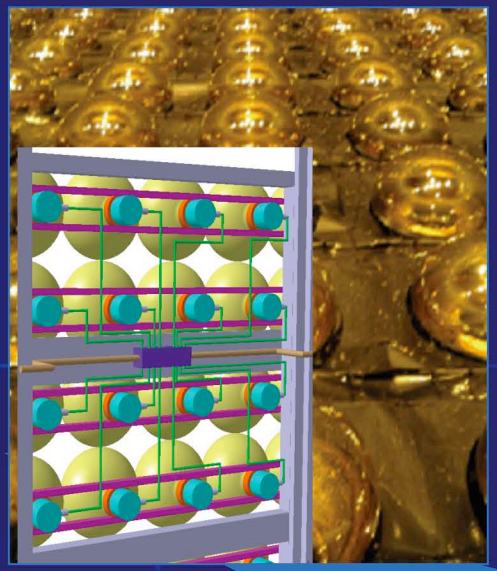
Funded 500k€/3yrs (1 post-doc included) designed to involve 5FTE Engineers
And in fact ~20p participate to our "monthly" meeting.





*:95% of the requested money

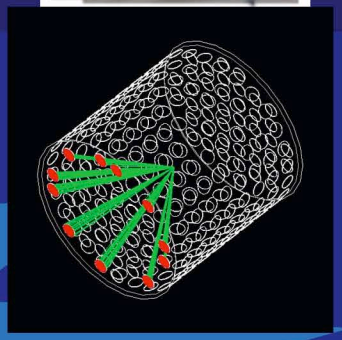
http://pmm2.in2p3.fr



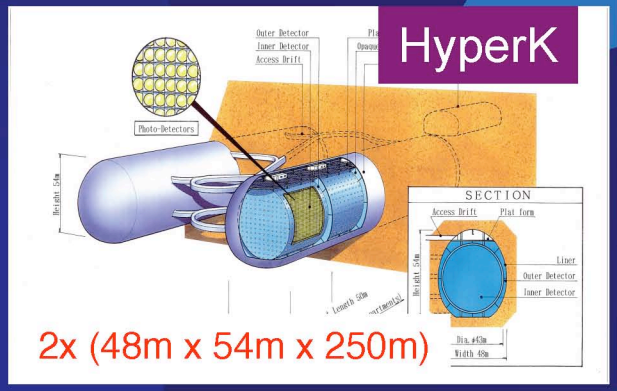
« PMm² » R&D

ANR

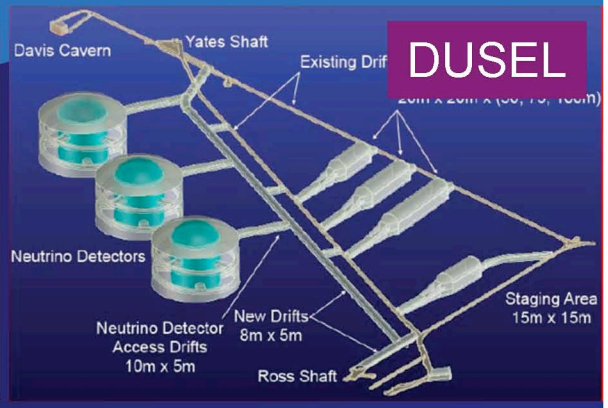
MEMPHYNO
Prototype Series



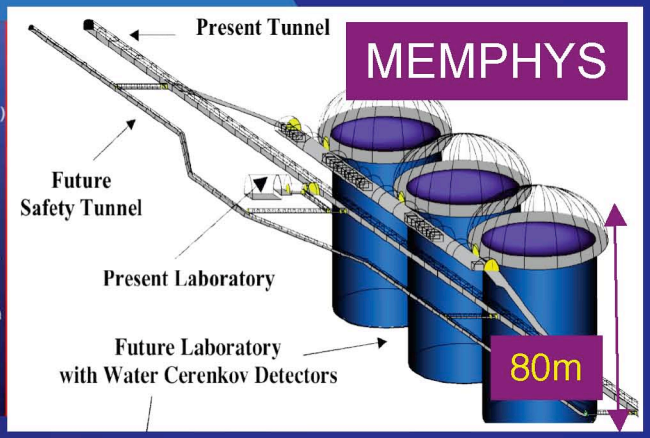
- Nucleon decay
- ν properties
- ν from supernova



Japan



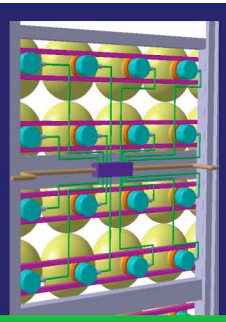
USA



EU

PMm²

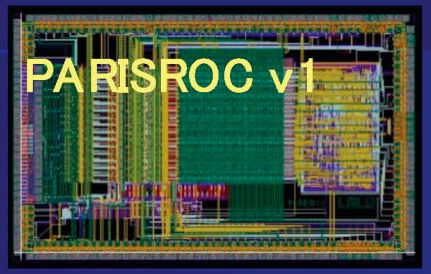
Our concept (2007)



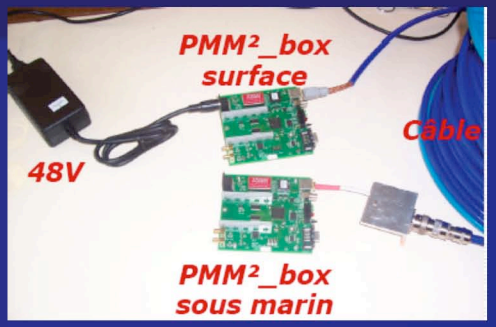
Realisation (2008)

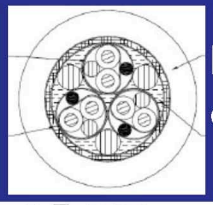
Integration "demonstrator" (2009)

IPNO CAO
Photonis Electrostatic et realisation (Sept. 08)
And cables, water tightness

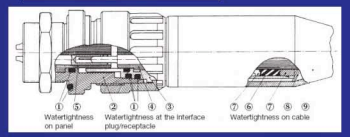


LAL ASIC SiGe 0.35µm (received Oct. 08) under test till Dec. 08

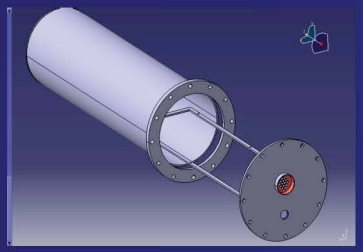




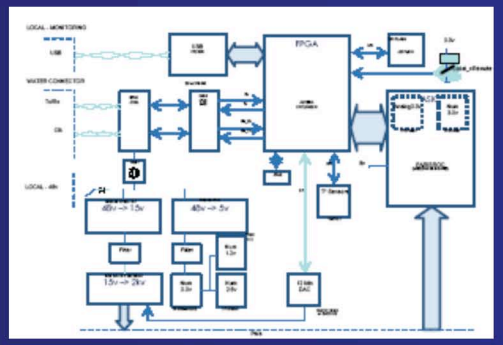
Hydrocable System



Souriau



LAL water tight box @ 10b under design (Dec. 08)



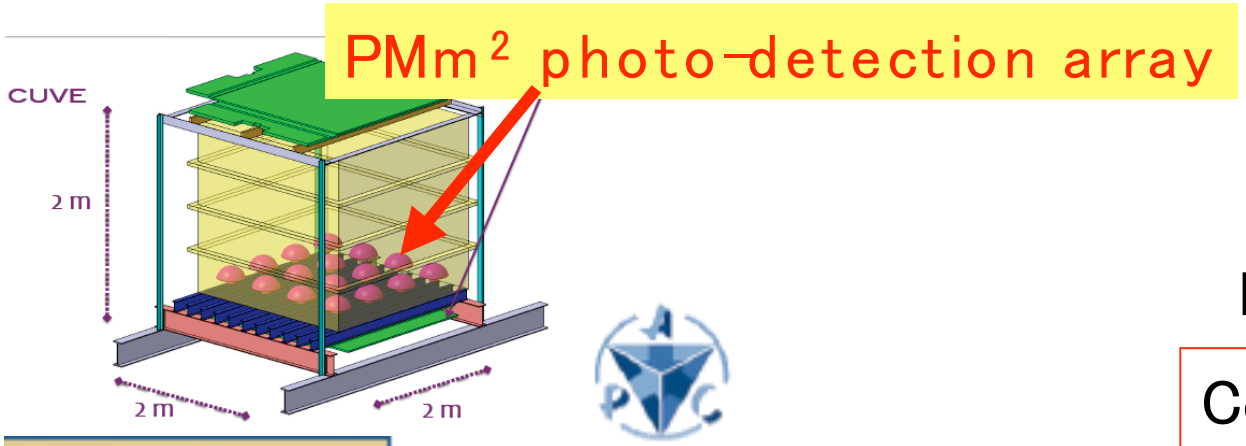
IPNO integration board under design

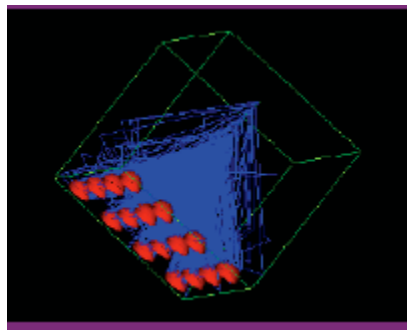
IPNO BNL vessel (Juil. 08) to test all the components under pressure @10b (Early 09)

LAPP
Trigegrless Data network 10Mbs to the "surface" + synchro GPS + puissance (Power over Ethernet)
Tests of submarine cables (photo: Hydrocable System Oct. 08) & connectors.

Schedule: ready Q3 09'

MEMPHYNO-I



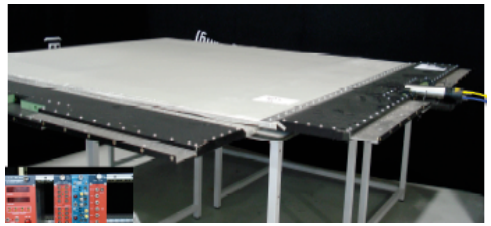


5 Gev muons

Foreseen Tests

Complet DAQ chain
Trigger threshold
Self trigger capability
Some Tracking

PEHD vessel
2mx2mx2m
Recycling water



Hodoscope from OPERA
Using MAROC2 LAL board

Operated first at APC, then at LSM Fréjus and may be at CERN on a test beam.

MEMPHYNO-I

= Test system with
16 PMTs and readout

- The purpose of this device is to perform some basic tests on post-PMm2 although it will not be possible to register proper Cerenkov cone (ČC) and only **one PMm^2** device will be used limiting the read out tests that are key issue as: **synchronisation of several devices, measurement *in situ* of the triggerless data flux, online reconstruction of ČC among PM dark current noise…**

MEMPHYNO-II

- bigger WČ to be operated in a new hall of the next extension of the LSM. Call for LoI mid-2009 workshop.
- The purpose is to register in situ all kind of events (passing muons, natural radioactivity electrons, photons and neutrons) and to reconstruct the associated ČC. From recent mails with B. Svoboda, there is interest of Gd loading.
- This imply to setup a complete acquisition chain with multi-PMm^2 devices all synchronised

PArISROC description (I)

- Complete front-end chip with 16 channels

  Sent in fabrication in **June 2008**

  Technology : **AMS SiGe 0.35 μm**

- Characteristics :
  - 16 inputs preamplifier
    - **Variable gain :1 → 8 (4bits) (common on 16 channels)**
    - **PMTs gain adjustment by a factor 4 (8 bits) (channel by channel)**
    - **Input dynamic range : 0 → 300 pe (0 → 50pC)**
    - **Good linearity (1%)**
  - 16 trigger outputs:
    - **Fast shaper (τ=15ns)**
    - **Low offset discriminator**
    - **Threshold provided by common 10bit DAC +4bit DAC/ch. (1/3 pe)**
    - **"OR" of 16 triggers output**
  - 1 digitized and multiplexed charge output :
    - **Dynamic range : 0 → 300 pe**
    - **Slow shaper with variable shaping time (τ=50ns,100ns,200ns)**
    - **SCA with depth 2**

PArISROC description (II)

- Coarse time measurement (timestamp) :
  - 24-bit counter @ 10MHz
  - Step : 100ns

- 12-bit ADC for charge and fine time measurement :
  - Wilkinson type ADC
  - T&H on slow shaper for charge measurement
  - T&H on TDC ramp (100ns) for fine time measurement
  - 2 discriminators with 12 bit ramp (100µs) as threshold

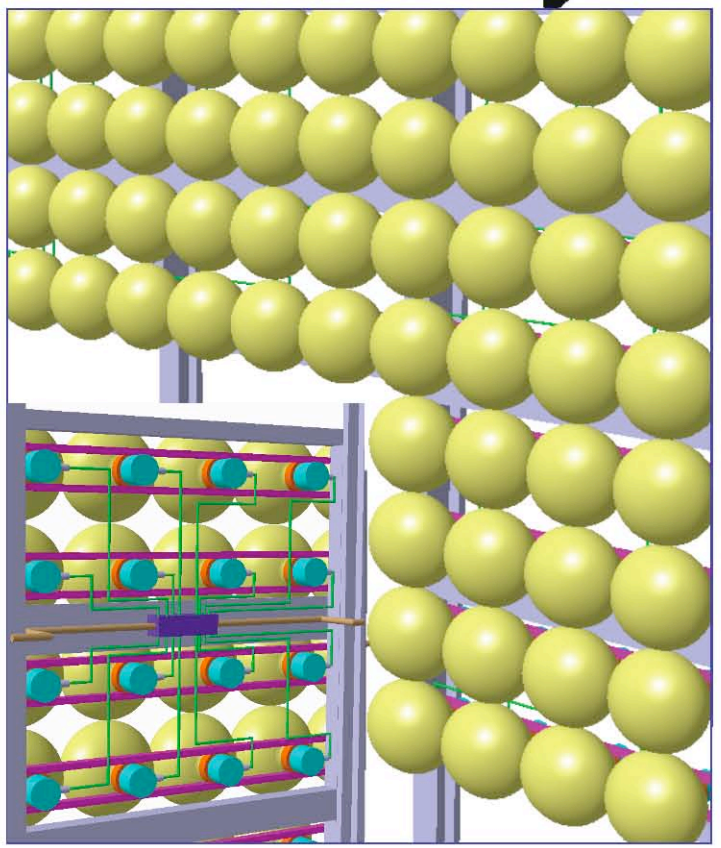
- Serialization of digital output information :

  Channel number - time stamp – charge - fine time

  4bits 24bits 12bits 12bits

PMm^2 : large photodection area

PMm2" (2006 – 2009), funded by the ANR : LAL, IPNO, LAPP and Photonis



eplace large PMTs (20") by groups of smaller ones (12")

- central 16ch ASIC (PaRISROC)
- 12 bit charge + 12 bit time
- water-tight, common High Voltage
- Only one wire out (DATA + VCC)
- Target low cost
- Reuse many parts from MAROC & SPIROC

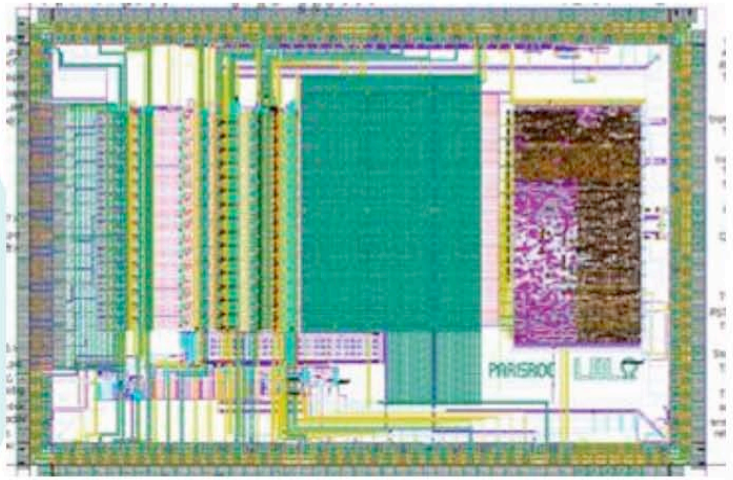
pplication : large water Cerenkov neutrino

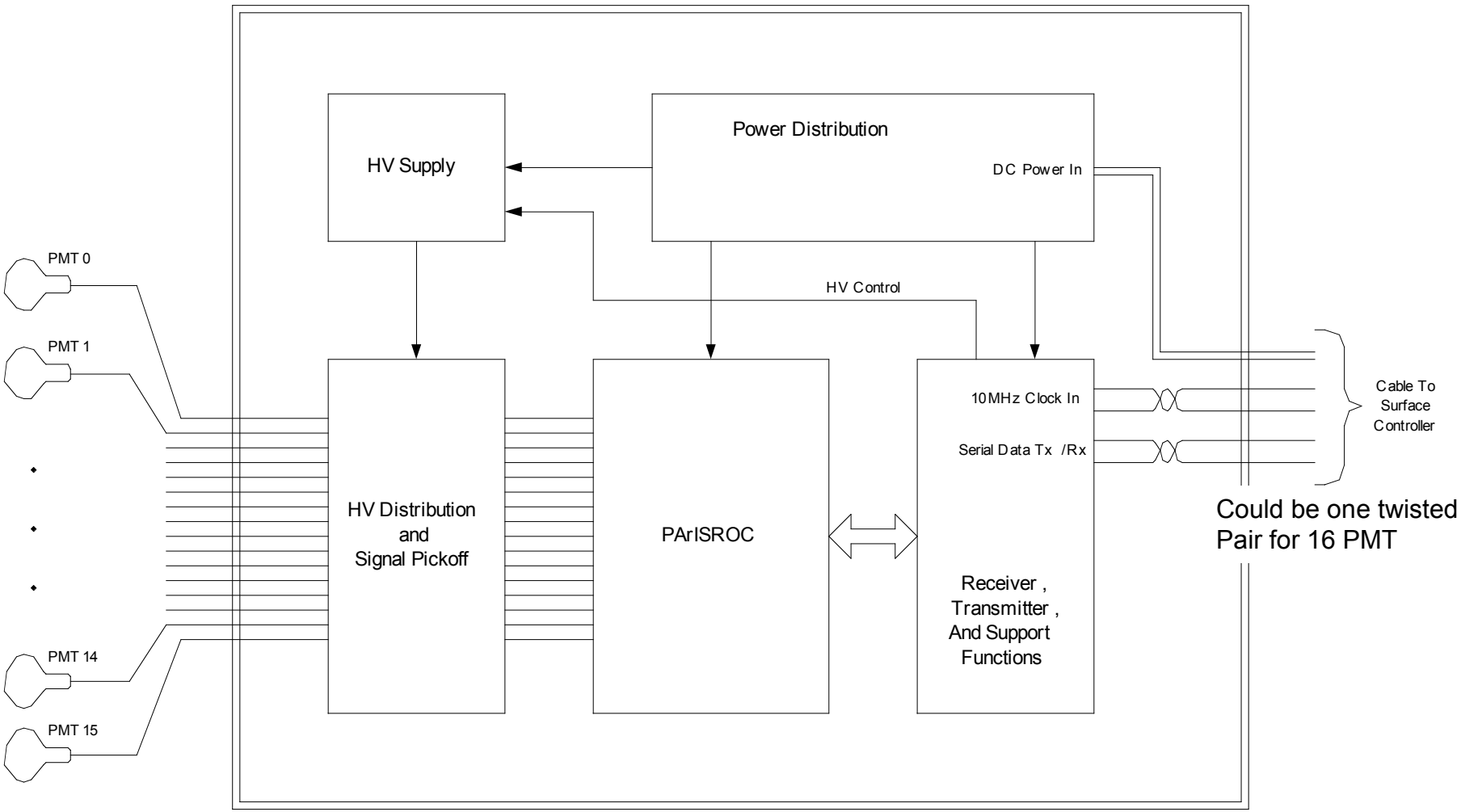
PArISROC

Photomultiplier Array Integrated in Sige Read Out Chip

PArISROC specifications

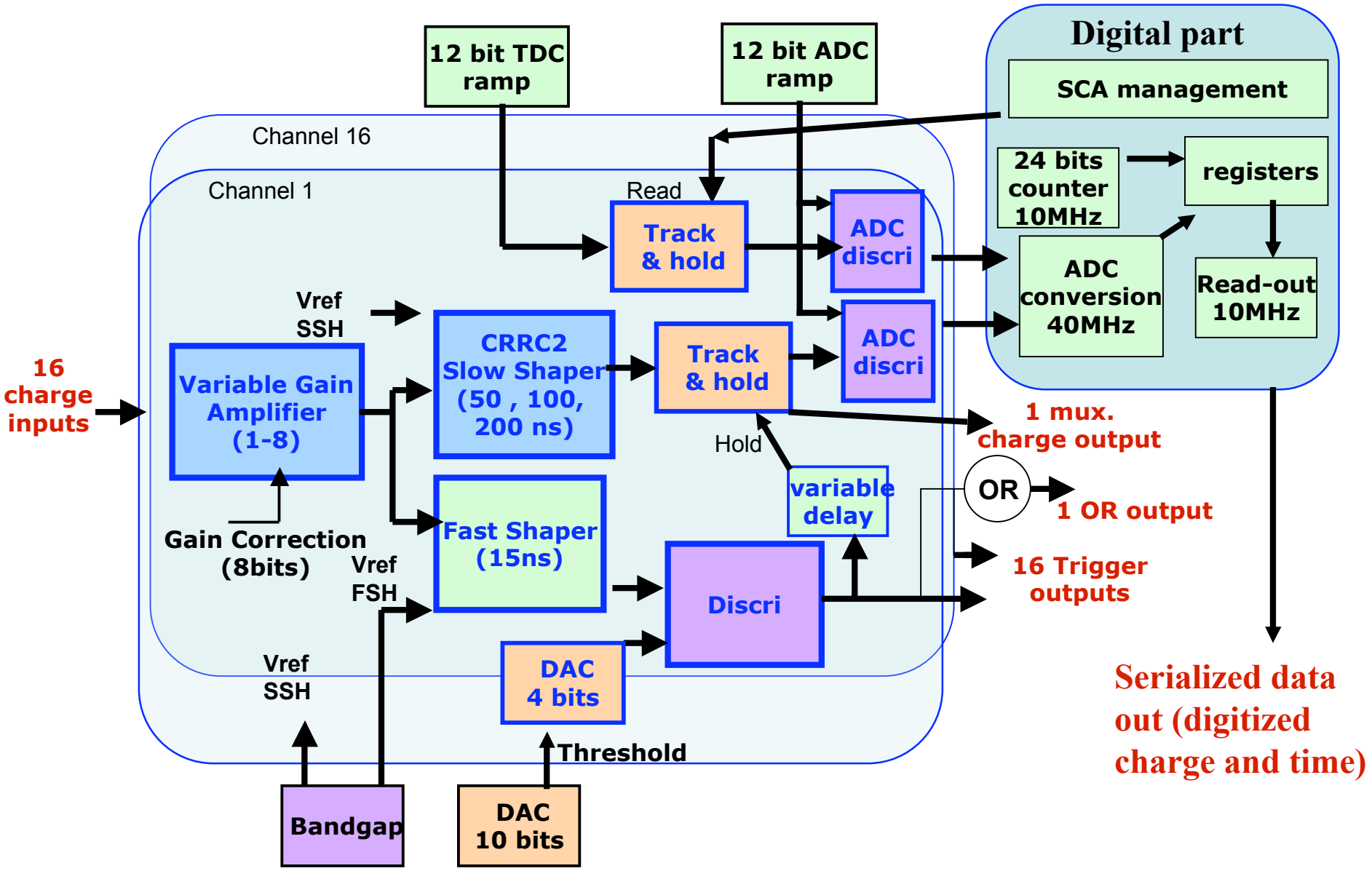
- Based on a complete 16 channels read out chip with dedicated for Photomultiplier array (PARISROC)
- Measurement of Charge and time





PArISROC Performs Data Acquisition on a 16-PMT Assembly For LBDUSEL

PArISROC architecture



Summary analog part

Preamplifier's Characteristics :

- 16 inputs preamplifier
- Variable gain :1 → 8 (4bits) (common on 16 channels)
- PMTs gain adjustment by a factor 4 (8 bits) (channel by channel)
- Dynamic range : 0 → 300 pe (0→ 50pC)
- Linearity < 1% (50pC)
- SNR = 30

Slow Shaper 's Characteristics :

- Time constant : t = 50,100, 200 ns peaking time
- Linearity <0.4% (55pC)
- SNR = 5 (RC=200ns);
  8 (RC=100ns);
  11 (RC=50ns)

Fast Shaper 's Characteristics :

- Time constant : t=15 ns
- SNR = 28

Discriminator 's Characteristics :

- Timewalk = 4 ns
- Threshold = 50 fC= 1/3 pe

My summary from visit to Orsay

- ASIC chip designed at Orsay likely to meet requirements for Dusel water cherenkov PMT pulse digitization.
- Strong team at Orsay. Possibility of worldwide collaboration on water cherenkov.
- Kael Hanson at Brussels University Libre working with Orsay on DAQ software with goal of test setup.
- Possibility to set up a test system at PSL in previous IceCube temperature controlled dark test lab if collaboration considers this approach worth investigating.
- There will be a new run of the chip. Opportunity to provide feedback on requirements, eg dynamic range until April.